Visually-Induced Motion Sickness

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What differences are there between the natural world and a (perfectly-produced) 3D stereoscopic image which could lead to complaints?

1. Response of the accommodation and convergence systems
2. Unnatural perspective
3. Sharpness of the diplopic image
4. Vection & Visually-Induced Motion Sickness (nausea)

“It was January 15, 2010. While many were having a great time watching the 3D presentation of “Avatar” at the AMC theatre, I was having a completely different experience. About an hour into the movie, I started feeling really sick, and I mean, REALLY sick.

It wasn’t the flu, nor was it some kind of food poisoning. It was actually motion sickness from the 3D effects, and it was really taking its toll on my eyes, head…and stomach. It wasn’t just me, either – a friend also started getting these symptoms…

The first half hour to 40 minutes was the time period where I started feeling strange. After about 45 minutes or so, that feeling quickly progressed to being flat out sick. The symptoms: extreme nausea, sweating and a bad headache. Near the end of the movie, I could explain the way I felt to be similar to that of drinking 5 shots of jack Daniels and 3 pints of beer on an empty stomach, and then waking up the next morning.

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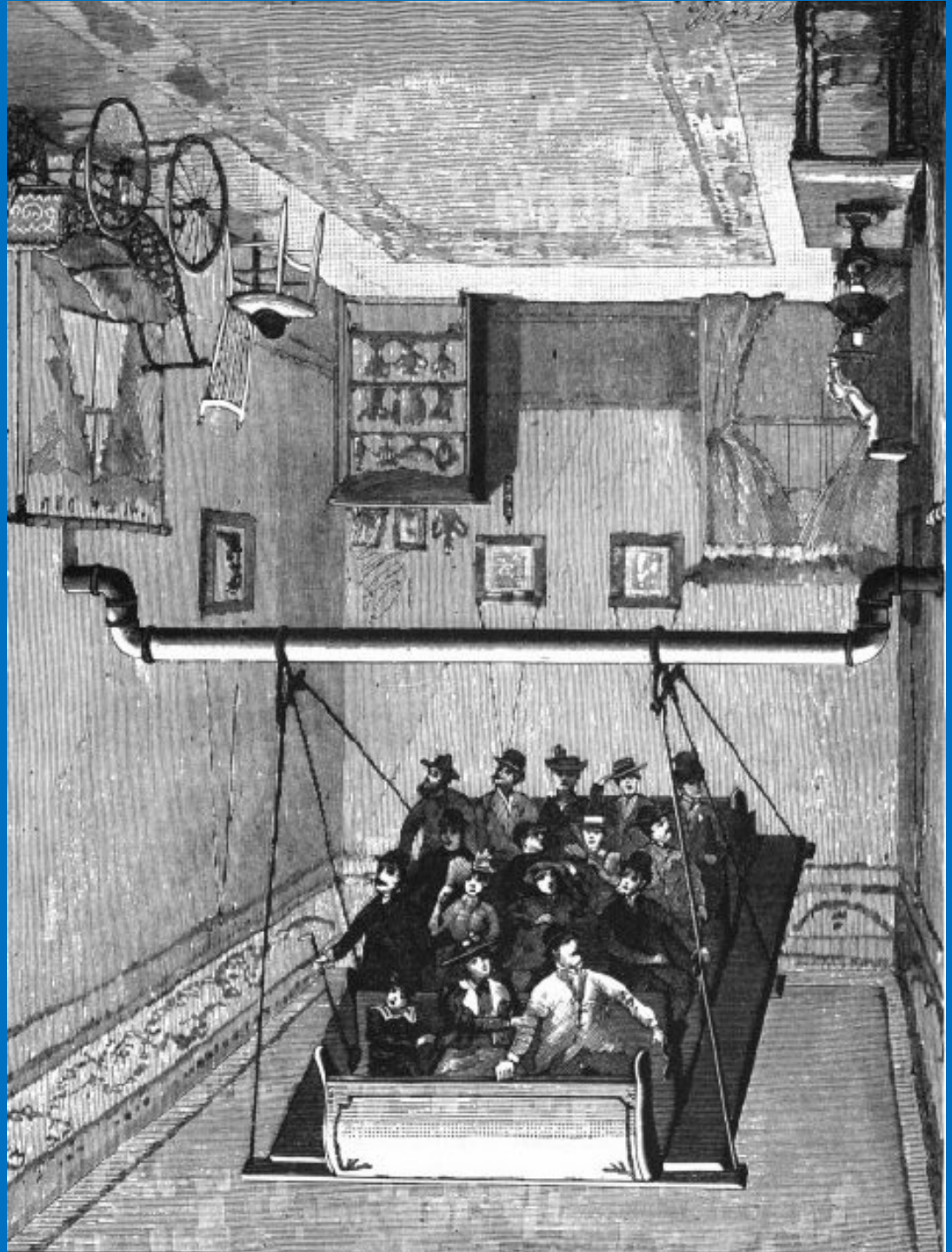
http://www.squidoo.com/3dsickness

Vection

Los Angeles
1890's

Haunted Swing
Illusion



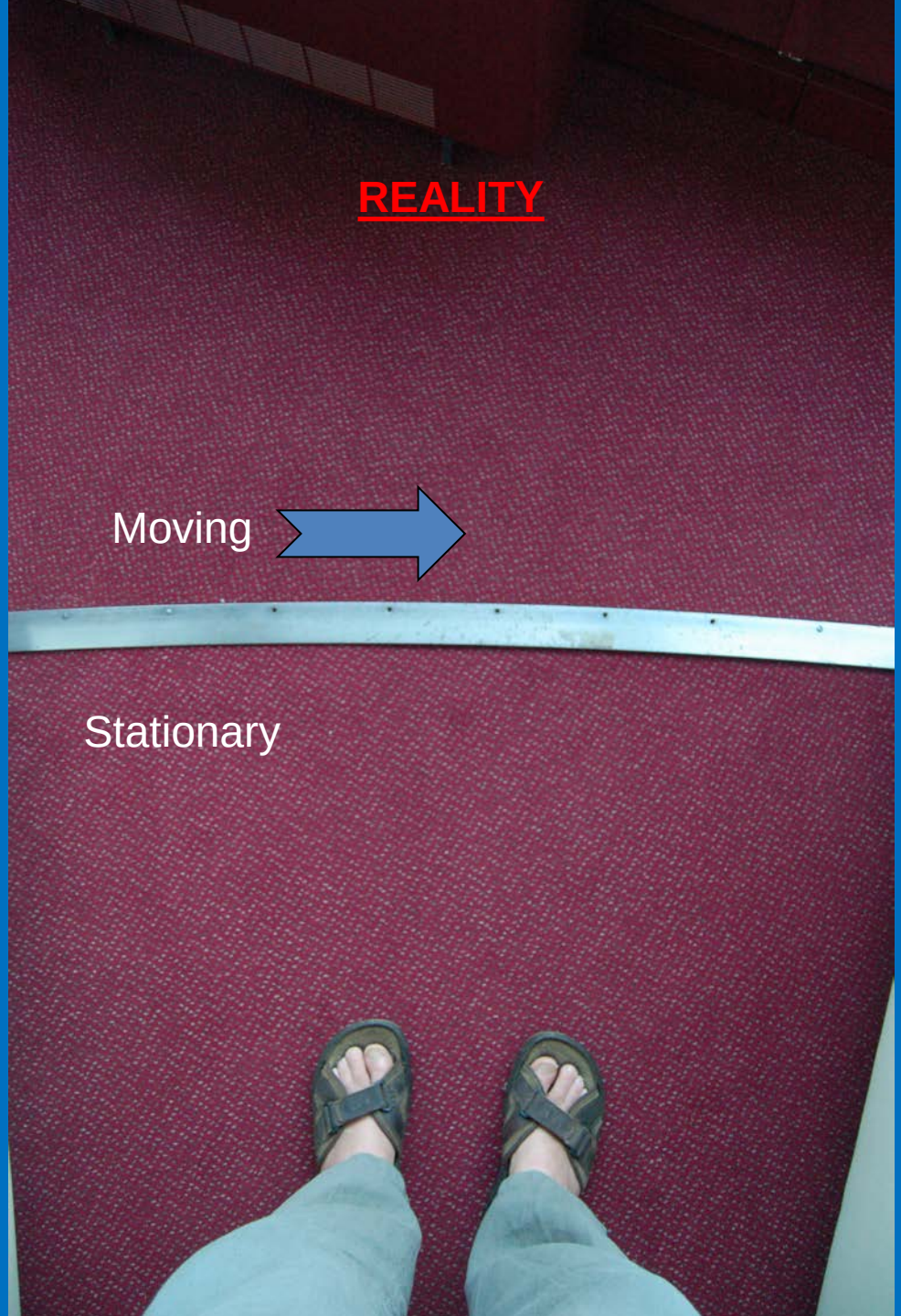
Vection

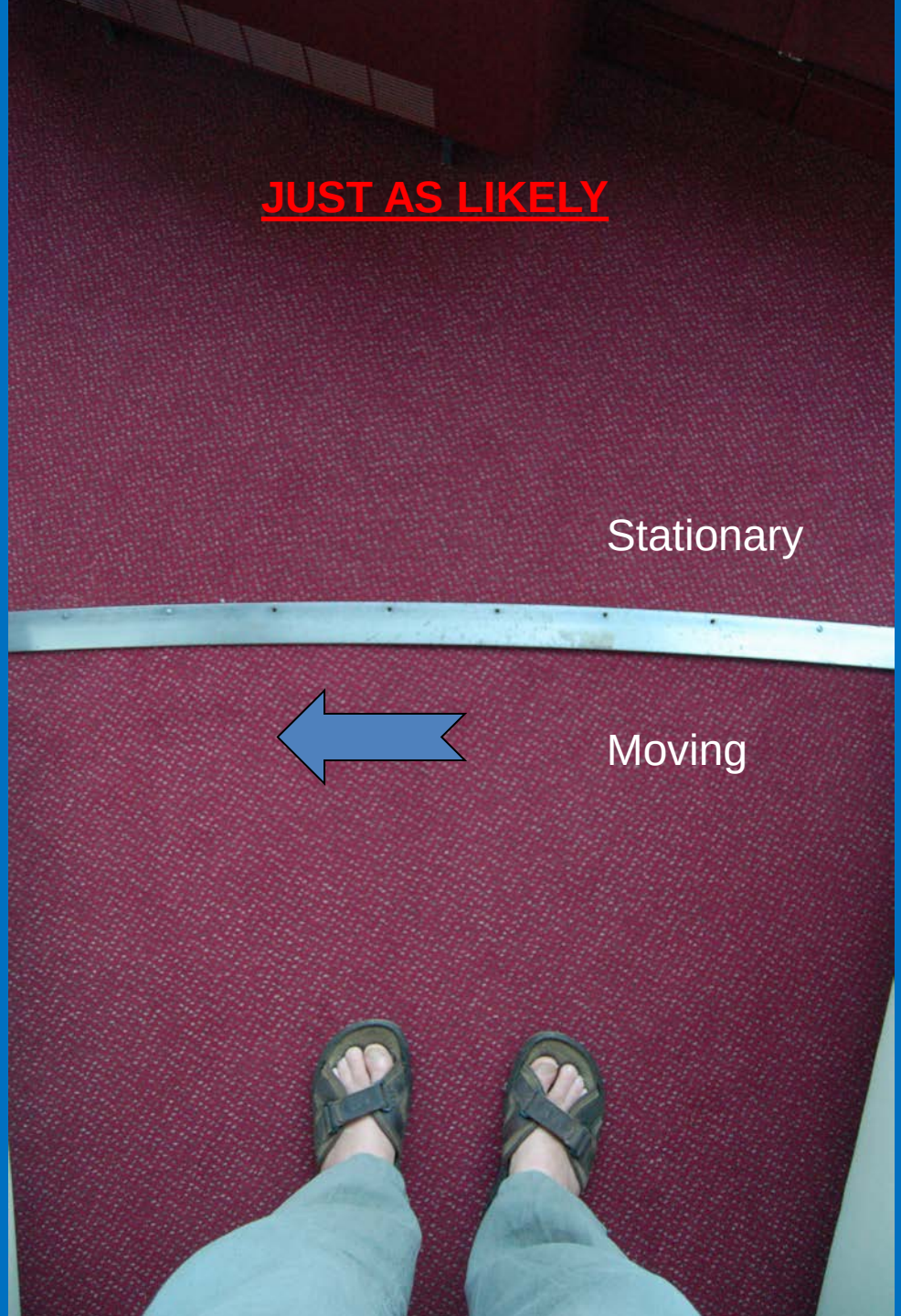
Why do we feel that we are moving, when we are not?

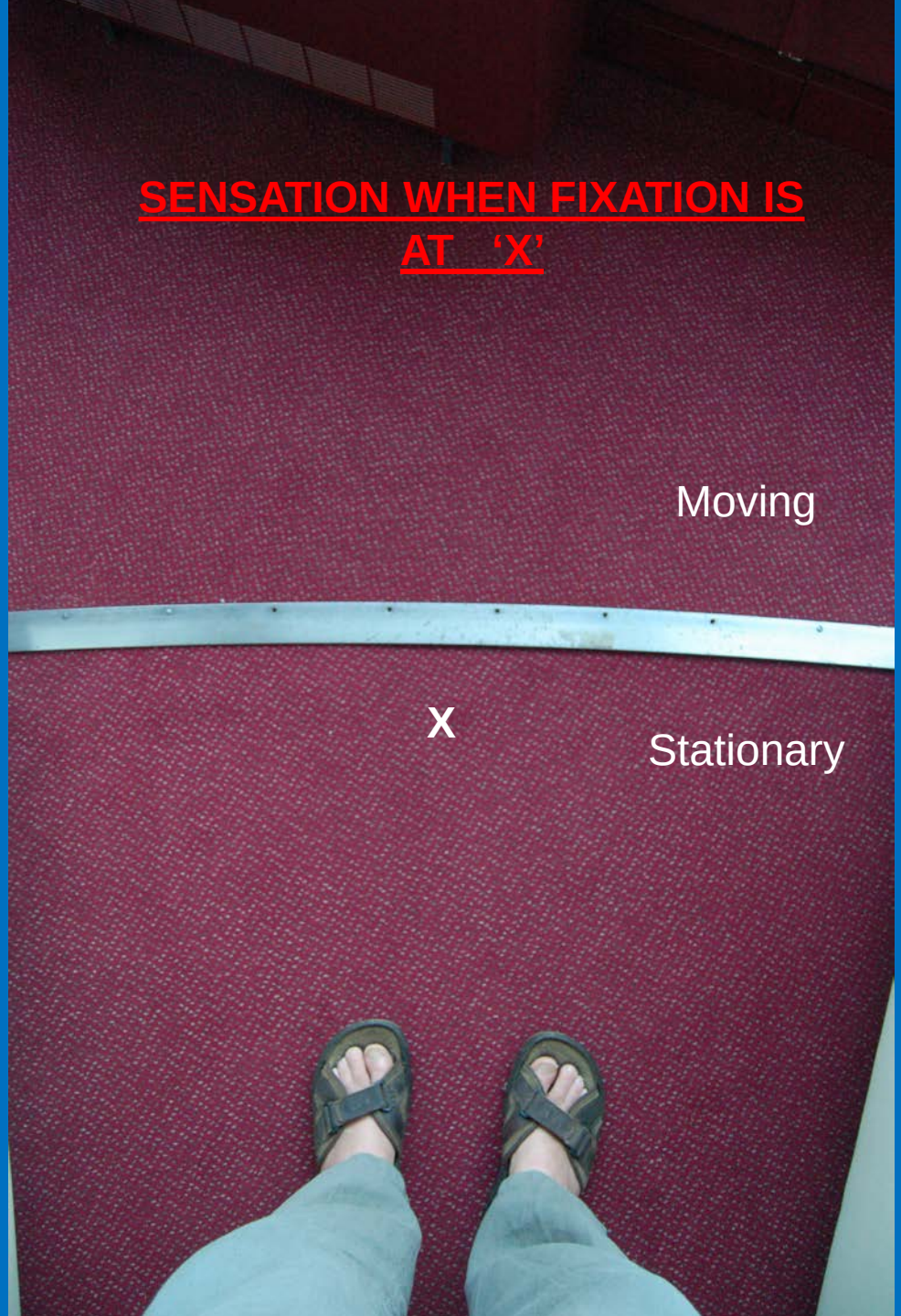
Kamzik Tower
Bratislava
Sovakia

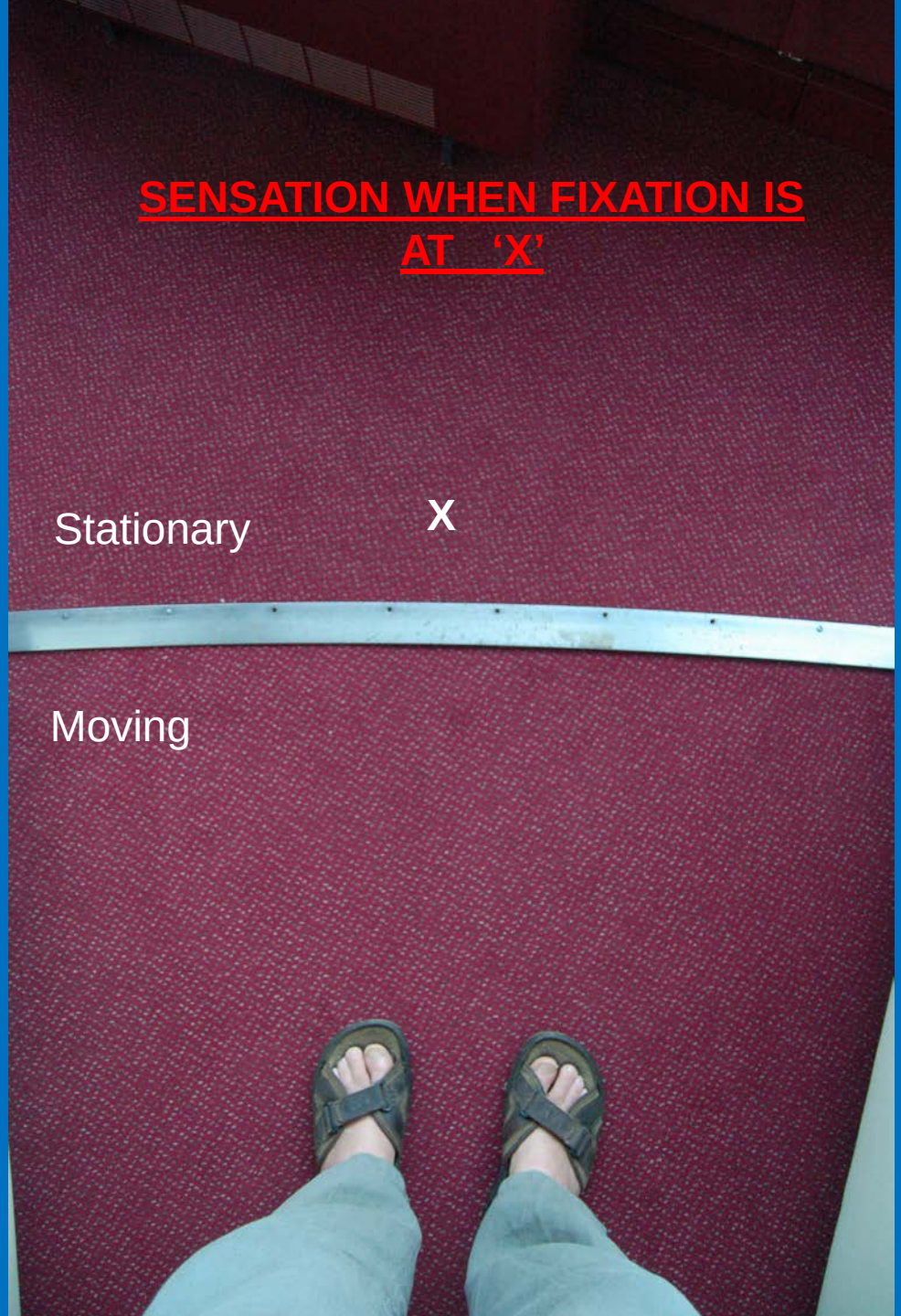
Me


VEŽA


REALITY
Moving
Stationary


JUST AS LIKELY
Stationary
Moving


SENSATION WHEN FIXATION IS AT 'X'
Moving
X
Stationary


SENSATION WHEN FIXATION IS AT 'X'
Stationary
X
Moving

Current Theory?

Sensation determined by eye movements
In one condition the eyes move, in the other they do not.

Does vection give rise to motion sickness?

Driving Simulator

Vection can give rise to VIMS – Visually-Induced Motion Sickness

Background:

HSE project
HMD/ Virtual Reality side-effects

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HSE project
HMD/ Virtual Reality side-effects

Different hardware (HMDs)
Different software (games/tasks)

Figure 3.22. Pre/Post change in reported simulator sickness symptom level: Division VR condition (N=4

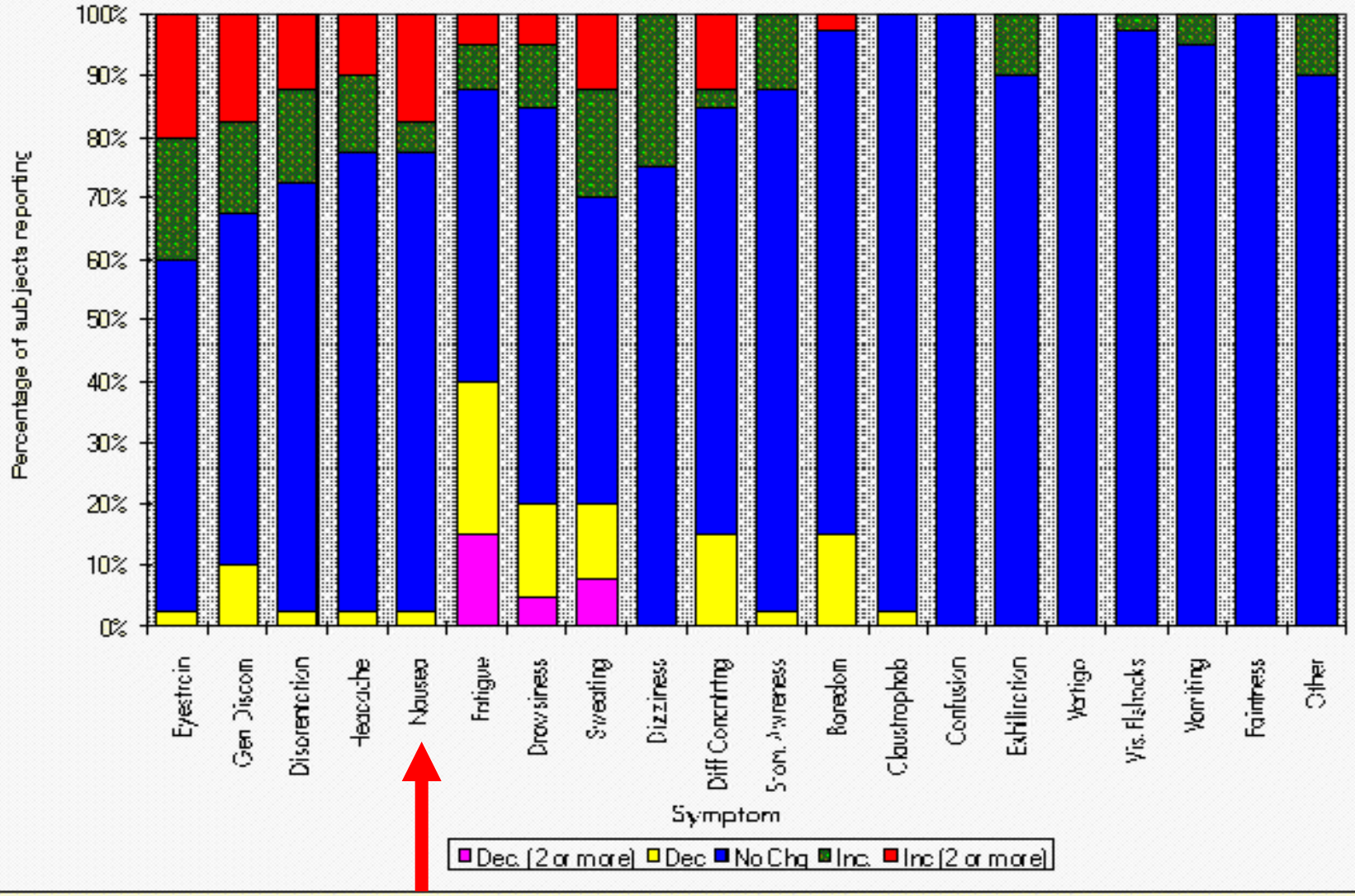
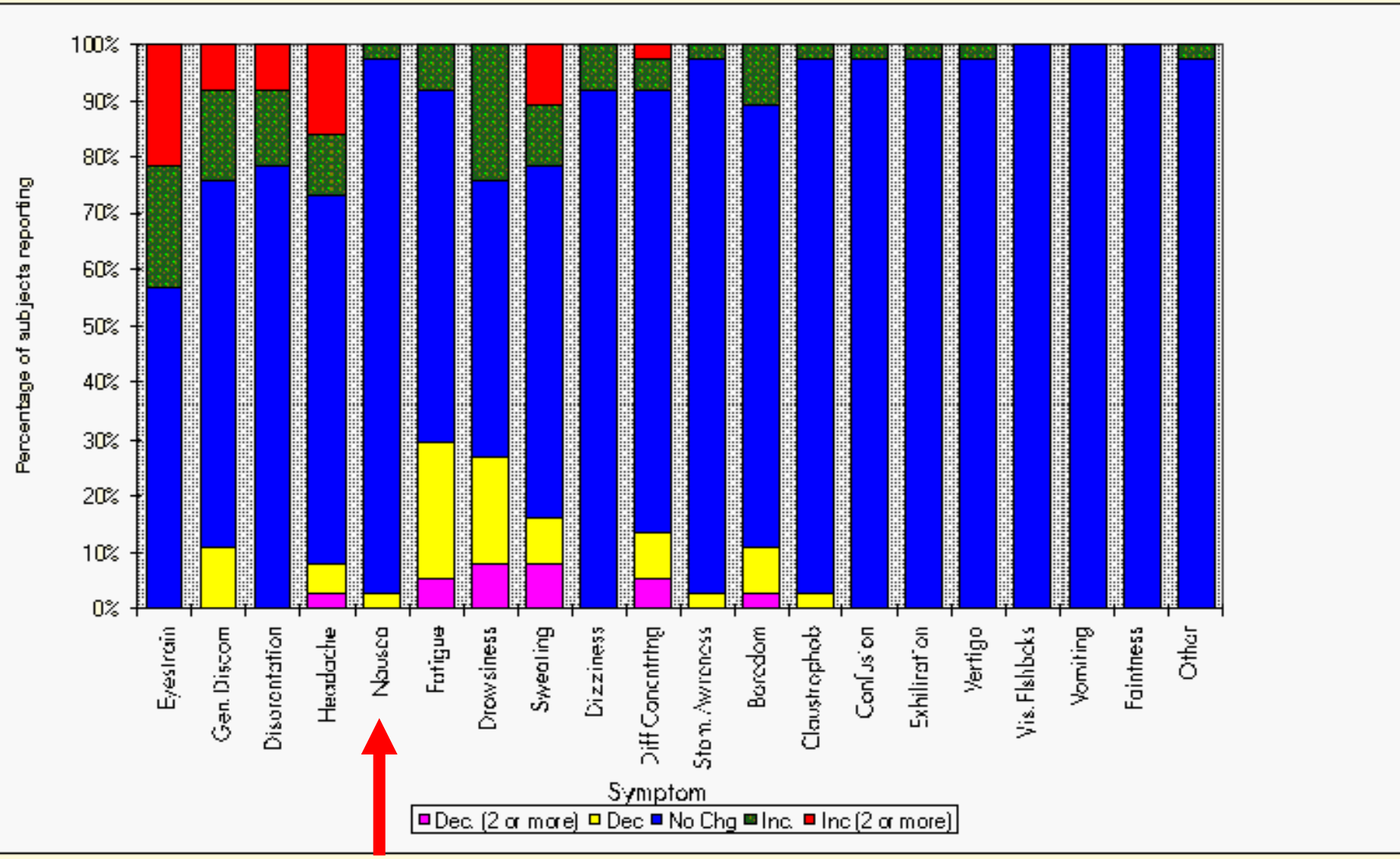


Figure 3.21. Pre/Post change in reported simulator sickness symptom level: Virtuality VR condition (N=37)



HMD/ Virtual Reality Side-effects:

Different side-effects depending upon stimulus conditions

HMD wear + moving head & body –
Significant symptoms:
nausea, disorientation, dizziness

Virtuality game –
moving forward only, nausea-free

Question which arose:

Why should the direction of vection influence the nauseogenicity?

Vection

what information is available to us from our senses?
how do we make sense of this information

VIMS:
Visually Induced Motion Sickness

We cannot consider the visual system alone when considering the symptoms – as these are not ***visual*** symptoms.

Sense organs

Vestibular system (Ears)

Otoliths

Semi-circular canals

- *provide information about CHANGE i.e. acceleration*

Visual System (Eyes)

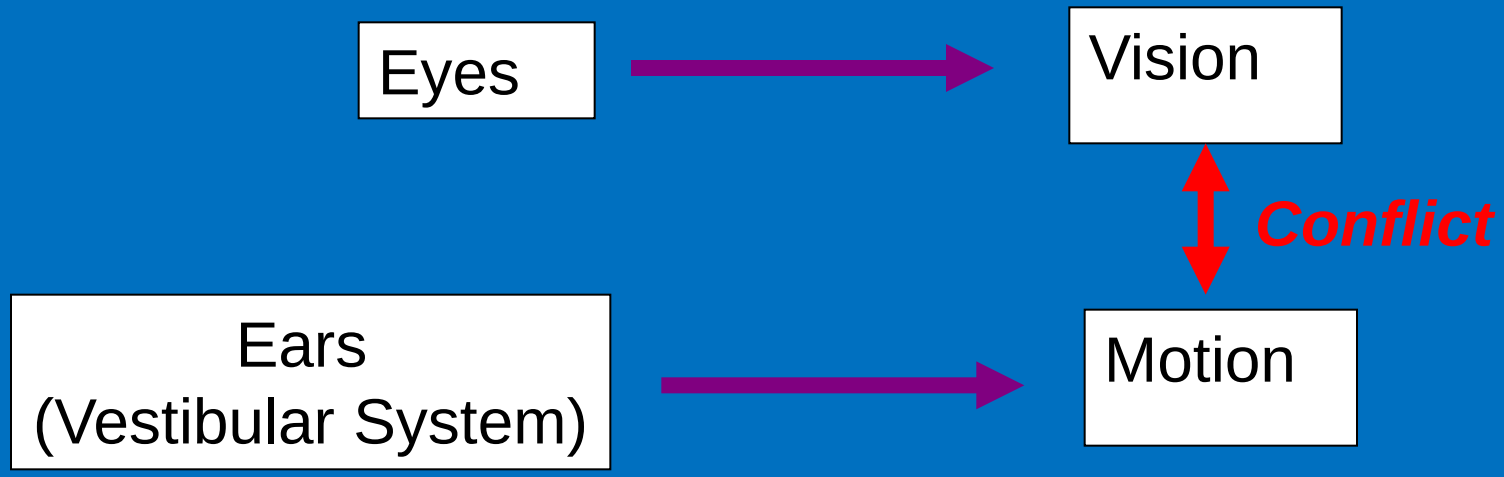
vision

eye movements

Visual-Vestibular conflict?

Traditional explanation for some forms of (true) motion sickness

Not universally-accepted (e.g Bles and colleagues)



Where is the conflict?
How is it monitored?

Reason (1978)

Neural Mismatch theory

Expectation (varies)

Does this apply to VIMS?

Do we see habituation?

Experiment:

Repeatedly expose people to a VIMS stimulus.

Do the symptoms decrease?

Howarth & Hodder 2008
Characteristics of Habituation to Motion in a Virtual Environment

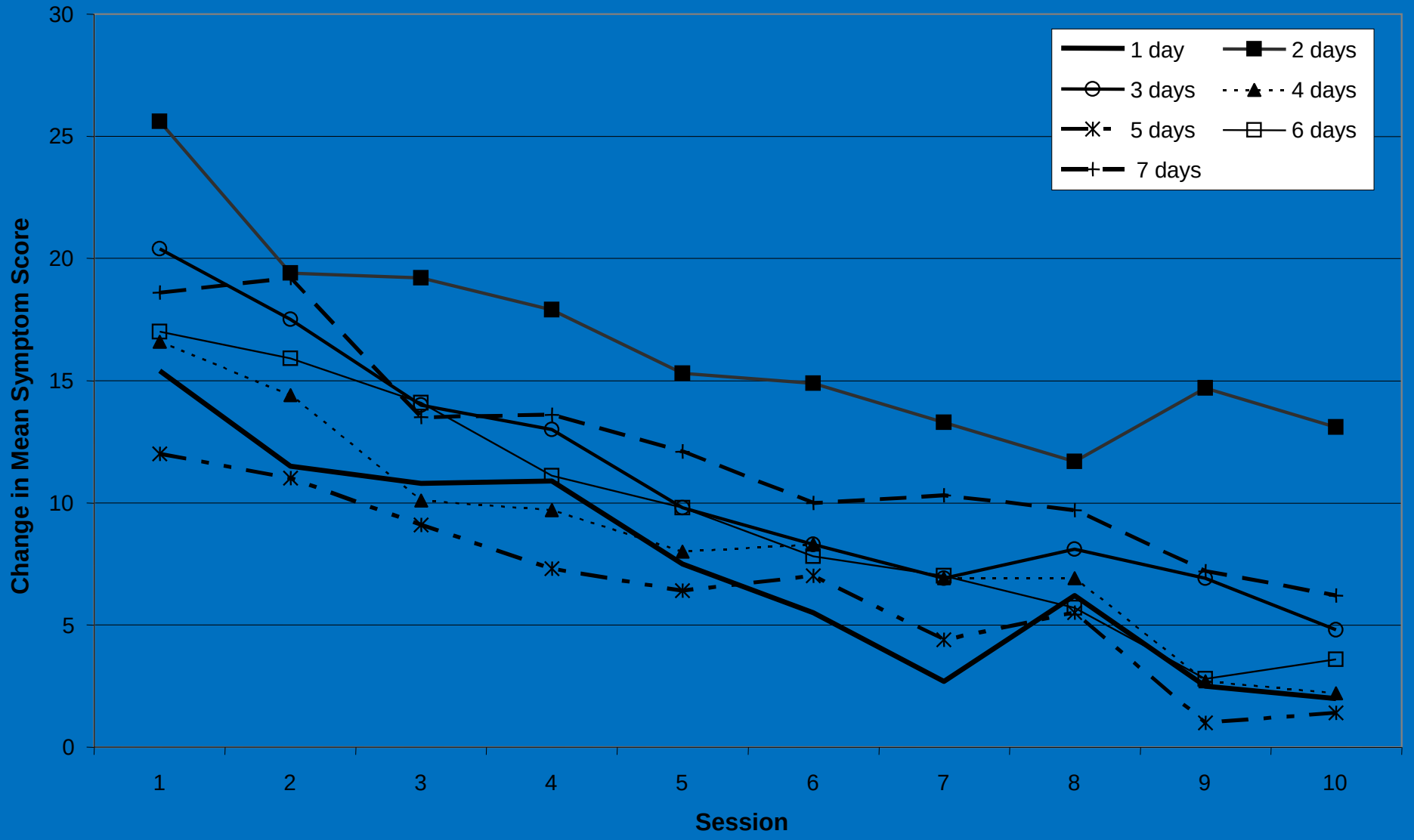
- 70 participants
- 7 conditions (different inter-trial interval)
- 10 trials per person
- 20 minute sessions; game ‘Killer Loop’
- Cybermind untracked HMD

No different ***objective*** changes over the ten trials

BUT

Large changes in ***subjective*** reports

The Reduction in Symptom Change over the trial with repeated exposures



Large changes in subjective reports

BUT

No different objective changes over the ten trials

HENCE the subjective changes came about through neural, and not ocular changes

- Habituation

- Vection without Nausea -
  Virtuality game; vehicle travel
- Conflict without nausea –
  travel at a constant speed
- Nausea without Vection -
  Sea-sickness with eyes shut
- Nausea without Vection -
  Howarth & Costello (1997)

The Occurrence of Virtual Simulation Sickness Symptoms When An HMD Was Used As a Personal Viewing System

P.A. Howarth and P.J. Costello (1997)

Non-tracked Bi-ocular system (c.w. wearing glasses with screens to view a film whilst on a plane). Control = VDT

Game: chess; Time: 1 hour; n = 20

Issue here is that when head moves, the screen moves as well – unnatural visual stimulus (but no vection)

Subjects showing an increase
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
n = 20
No Change
Increase
general discomfort
fatigue
boredom
drowsiness
headache
eyestrain
sweating
disorientation
nausea
difficulty concentrating
dizziness
stomach awareness

VDU

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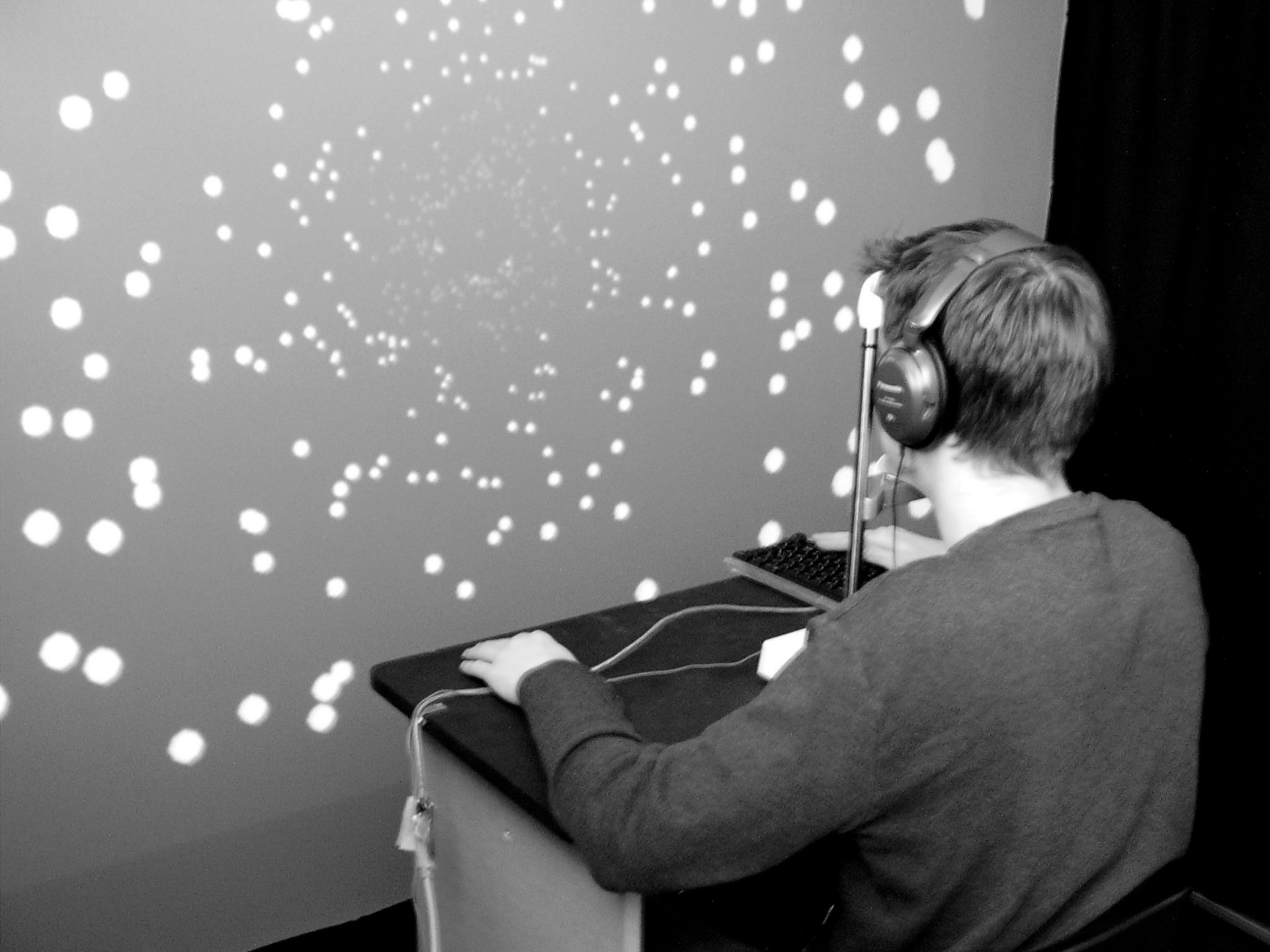
HMD

Differences between the two conditions in simulator sickness symptom increases

General discomfort	$p < .001$
Fatigue	$p < .001$
Boredom	Not Sig.
Drowsiness	Not Sig.
Headache	$p < .001$
Eyestrain	Not Sig.
Sweating	Not Sig.
Disorientation	Not Sig.
Nausea	$p < .001$
Diff. concentrating	Not Sig.
Dizziness	$p < 0.05$
Stomach awareness	$p < 0.01$

How does the direction of stimulus motion (the ‘flow pattern’) affect VIMS?

Experiment using different flow patterns (Diels)



Stimulus conditions

Real time; frame rate of 60 Hz

Images backprojected onto a tangent screen (190 cm x 145 cm) with a Hitachi CP-X958W/E projector (1024 x 768 pixels).

Display: 500 white dots with a luminance of 10.82 cd/m^2 randomly positioned on a black background of 0.35 cd/m^2

Dot velocity and size varied exponentially as a function of their simulated location in depth. Dot size at the eye ranged from 0.22º at the middle to 2.97º at the periphery.

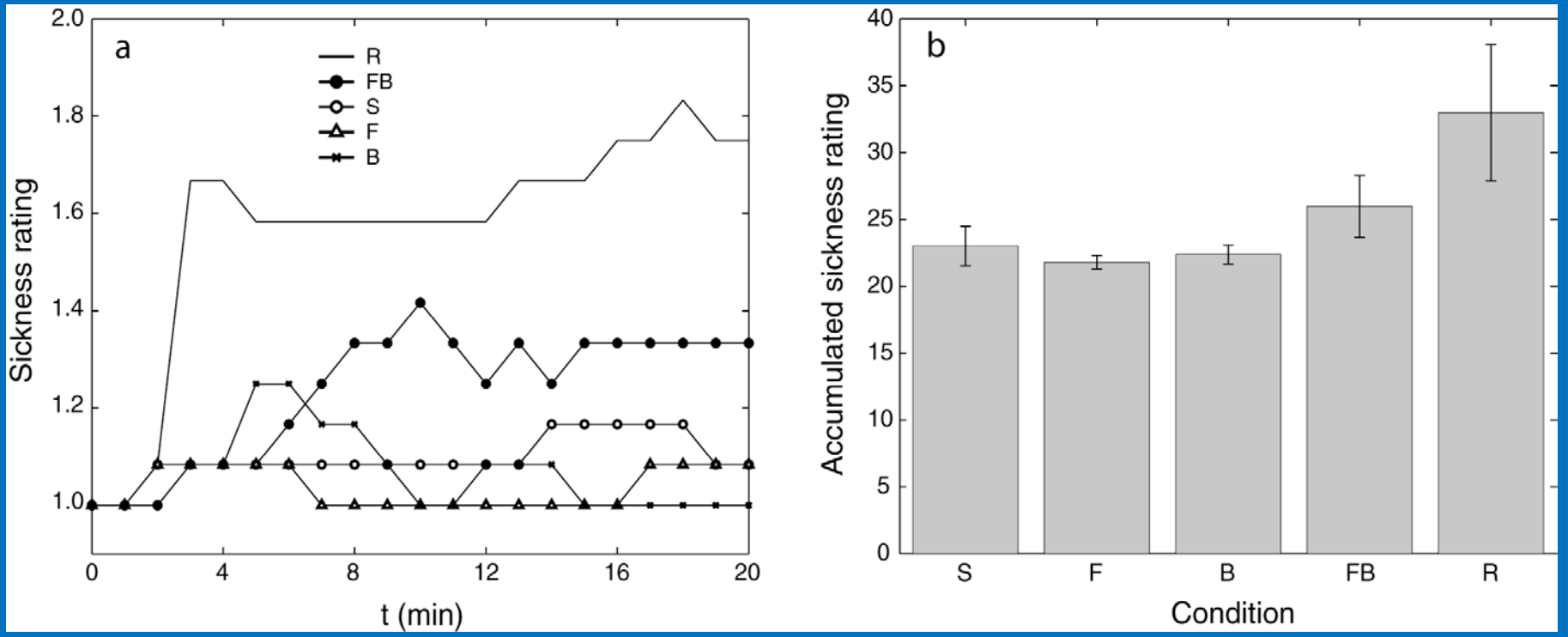
Five conditions:

1. Stationary (S)
2. Forward (F)
3. Backward (B)
4. Forward/Backward (F/B)
5. Roll (R)

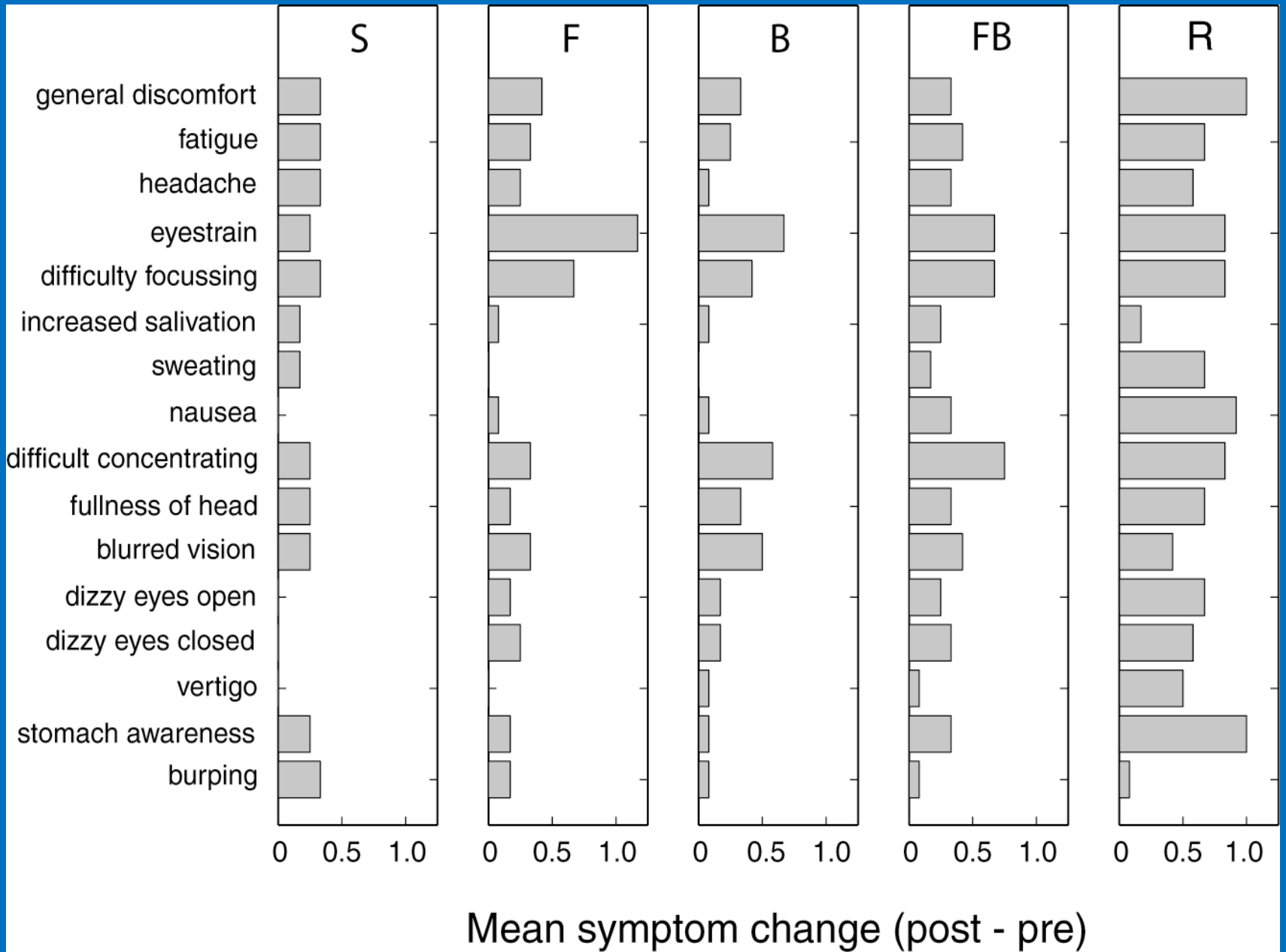
posture + roll.MOV

(a) Mean sickness rating as a function of exposure duration.

(b) Mean accumulated sickness ratings (± SEM).



Mean change (post – pre score) in symptom severity of individual SSQ symptoms for the five conditions.



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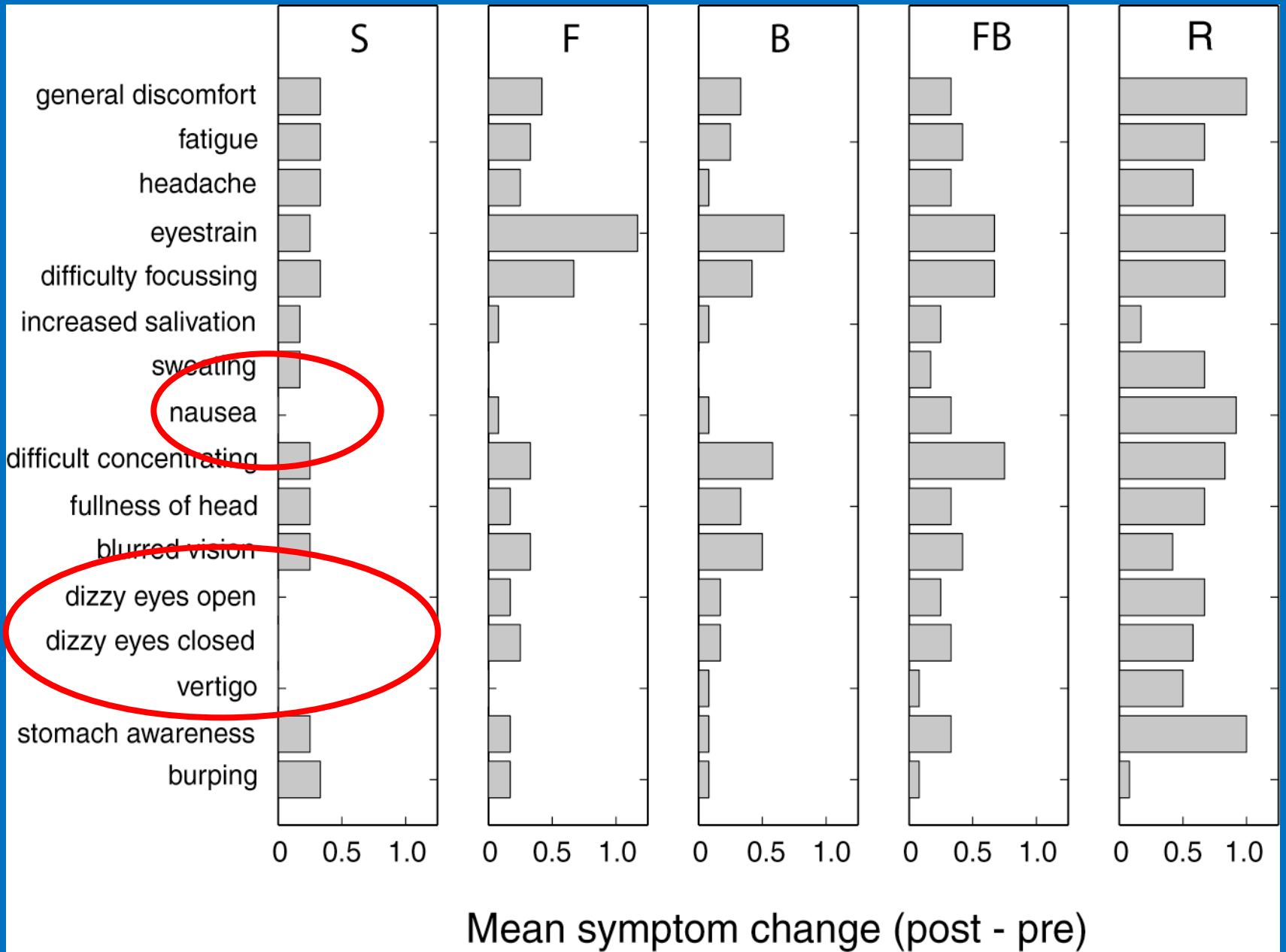

Summary:

- Little effect of F-B movement?
  (c.w. earlier result from HSE study!)

- ‘Natural’ motion less nauseogenic

Relevance to complaints from people viewing 3D stereoscopic images?

- Titanic - ‘2D’ (i.e. non-stereoscopic)
- Blair Witch Project -‘2D’ (i.e. non-stereoscopic)
- Avatar - 3D Stereoscopic

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